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and the process must be repeated for every change of the barometer tube's position which involves also changes of rate and heat-compensation.

All this work is required with Mr. Denison's compensation precisely as with mine. It was seven years before I was satisfied with my work; and it was this experience which induced me to recommend, in preference to my own invention, the placing the pendulum in an atmosphere of hydrogen.

On the Barometric Error of Clocks. By R. Webster, Esq.

The paper of Mr. Carrington in the *Monthly Notice* for November, "On the rate of a Clock going in a Partial Vacuum," and the subsequent papers by Dr. Robinson and Mr. Denison in the January number, have led me to investigate the same subject.

Since May 1872, I have had a telegraphic wire direct from the Royal Observatory, conveying hourly signals of Greenwich mean-time, by striking on a bell. In the same room with this telegraphic apparatus, I have several astronomical clocks with gravity and dead-beat escapements. I have selected the best of these, the maximum deviation of which from Greenwich mean-time, since November 11th, 1872, to the present time, has not exceeded two seconds on each side of 0, and this I principally attribute to the barometric error. It has a dead-beat escapement, with jewelled pallets, jewelled escape holes, pinions of sixteen, mercurial pendulum with iron jar, and the arc of vibration is 1° 58′ on each side of 0.

On February 18th, a dense atmospheric wave passed over London, and the barometer indicated 30·76. A daily fall occurred until the 26th, when it marked 29·00, giving a range of 1·76 inches in eight days.

The following is the rate of the clock, the height of the barometer and the thermometer:

	Sec.	Bar.	Ther.
Feb. 17	− 0·1	30·22	46
18	− 0·3	30·76	47
25	0·0	29·68	44
26	+ 0·2	29·00	49

By taking the difference of rate on the 18th and 26th, the days of maximum and minimum of barometer we have

$$\frac{0{\cdot}50}{1{\cdot}76} = 0{\cdot}28$$

Comparing the 17th and 18th,

$$\frac{0{\cdot}20}{0{\cdot}54} = 0{\cdot}37,$$

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and comparing the 25th and 26th,

$$\frac{0{\cdot}20}{0{\cdot}68} = 0{\cdot}30.$$

The mean of these observations is 0·32.

Comparisons with the recorded rate of this clock and unusual variations of the barometer corroborate this result.

It may therefore be fairly assumed that for this clock the co-efficient of barometric retardation between 29·00 and 30·76 is 0·32 seconds per inch per diem.

New Use of the Altazimuth Diagram.

By the Rev. A. Freeman, M.A.

J. M. Wilson, Esq., of Rugby School, has suggested to me that the diagram, of which a sketch was given in the *Monthly Notices* for November 1872, at p. 23, may be used for quite a different purpose from mine; namely, for refraction corrections when observing out of the meridian with an equatoreal.

This is indeed easily understood. Refraction displaces a star towards the zenith along the line which represents the vertical circle passing through the star's true place as assigned with respect to polar distance and hour-angle. The effect on these two co-ordinates may be estimated, approximately, by a glance at the diagram, with the aid of the annexed short list of Bessel's mean refractions, taken from Loomis' *Astronomy*, Table VIII.

Mean Refractions corresponding to Zenith Distances.

Z.D.	M.R.	Z.D.	M.R.	Z.D.	M.R.
°	′ ″	°	′ ″	°	′ ″
10	0 10	70	2 37	84	8 23
20	0 21	72	2 56	85	9 47
30	0 33	74	3 19	86	11 39
40	0 48	76	3 47	87	14 15
45	0 58	78	4 25	88	18 9
50	1 6	80	5 16	88½	20 51
55	1 22	81	5 49	89	24 25
60	1 40	82	6 29	89½	29 3
65	2 3	83	7 20	90	34 54

St John's College, Cambridge,
Feb. 1, 1873.

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